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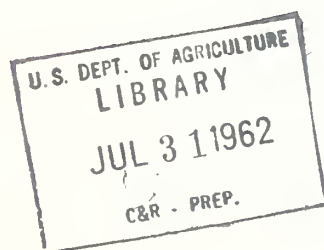


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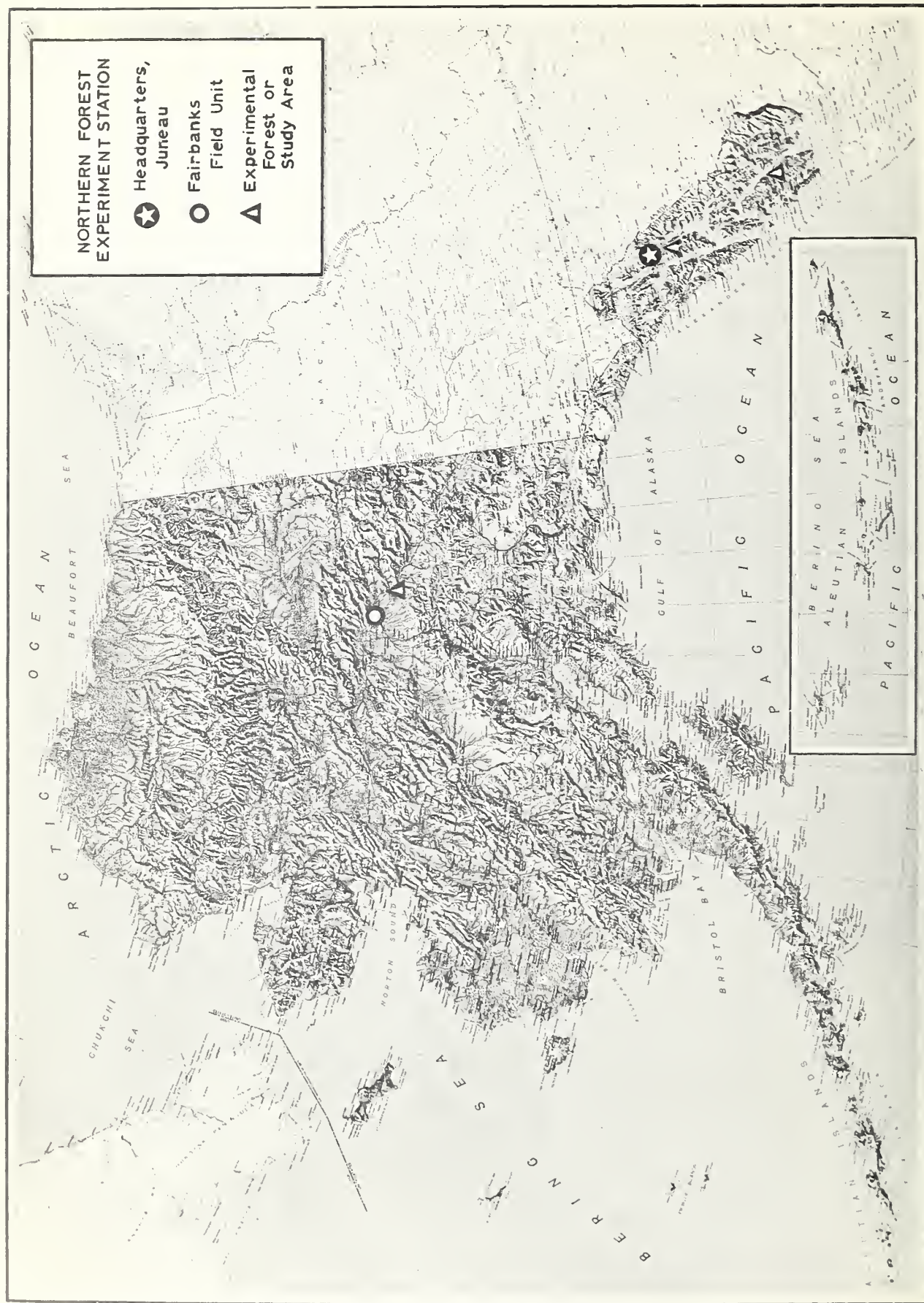
FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

Biennial Report

1960 - 1961



NORTHERN FOREST EXPERIMENT STATION
JUNEAU • ALASKA
RICHARD M. HURD • DIRECTOR



Photograph of U. S. Geological Survey Alaska Map E

foreword

"Northern Forest Experiment Station" replaced "Alaska Forest Research Center" July 1, 1961. The research program continued uninterrupted. Future research will probe more deeply into problems now under investigation and be expanded into areas hitherto untouched. Our continuing objectives will be to search for facts and knowledge about Alaska's forest and related resources, and to make this information available to all people interested in the management of those resources.

In 1961, Congress appropriated funds for the construction of a laboratory-office building in the Fairbanks area. The purpose of this building is to provide needed laboratory and office space for our scientists investigating ways of protection, utilizing, and perpetuating Alaska's interior forests. Arrangements have been made with the University of Alaska for a building site on the campus at College. Plans and specifications for the building are now being prepared.

The forest fire research program for the Interior forests was strengthened by starting a formal project at Fairbanks. Fire has been a constant enemy of the Interior forests; millions of acres have been burned and reburned. Our objective is to learn more about (1) causes of fire; (2) the plant, fuel, and weather conditions favoring the spread of fire; and (3) systems best suited for controlling fires.

We welcome the opportunity and accept the challenge that accompanies these recognitions given to Alaska's forest and related resources. The job is big; there is much to do. Your comments and suggestions on this report of our activities will be appreciated, as will those on other phases of our work.

Richard M. Hurd

1960 - 1961 Biennial Report
Northern Forest Experiment Station

contents

	Page
TREES	1
Coastal Forests	1
Interior Forests	7
SOIL AND WATER	11
FOREST INSECTS	15
FOREST INVENTORY	19
PUBLICATIONS	23

trees

coastal forests

● Natural Seeding continues to increase the stocking of western hemlock and Sitka spruce on an experimental 700-acre clear cutting on which logging began in 1954 and was completed in 1957. In 1958 this cutting was 50 percent stocked with seedlings forming the new forest. These seedlings came from seed produced during "medium" or poorer cone crops. In 1960 the stocking was increased to 80 percent following a "heavy" cone crop in 1959.

Natural seedfall into the clear cutting has ranged from more than 1,000,000 seeds per acre within 300 feet of the uncut forest that is the seed source to 300,000 seeds per acre 1,300 feet from the seed source (fig. 1). These are counts made after the heavy cone crop in 1959. Seed dissemination at these distances was 150,000 and 125,000 seeds per acre from a medium cone crop. From 70,000 to 125,000 seeds per acre were found as far as 3,000 feet from the seed source after medium or heavy cone crops. Even though natural seedfall diminishes rapidly with increasing distance from the seed source, the 700-acre block, as a whole, is satisfactorily stocked with seedlings established since the logging was completed.

Stocking percent is an expression of how well an area is provided with a new crop of trees. As used here, it refers to the percentage of one-thousandth acre plots containing one or more seedlings at least one year old, in good condition, and free to grow; or two or more seedlings less than one year old, in good condition, and free to grow. Our studies of natural seedfall and stocking are aimed at providing guides the forester can use in designing management practices that will assure adequate new forests following timber harvesting.

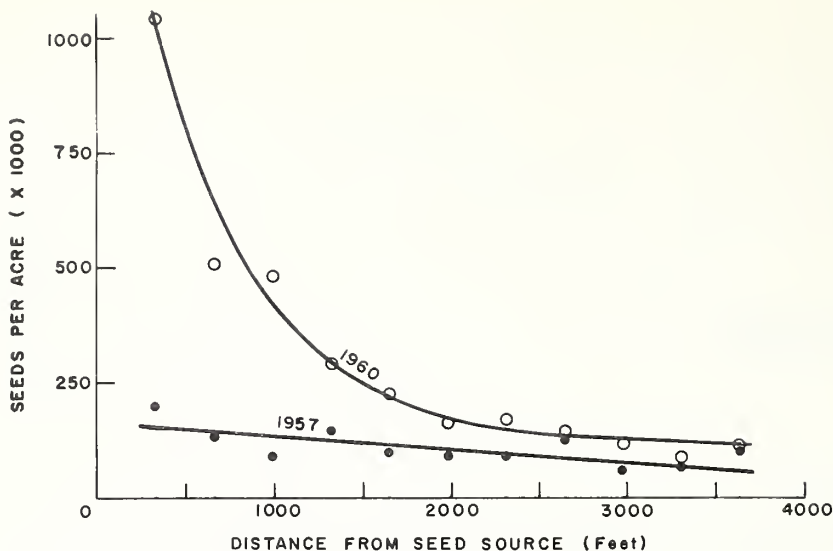


Figure 1. — Amount and distance of western hemlock and Sitka spruce seedfall into a 700-acre clear cutting in 1957 and 1960; Maybeso Experimental Forest, Prince of Wales Island, Alaska.

● Artificial Seeding significantly increased the number of new Sitka spruce and western hemlock seedlings on forest land cut over in 1958 through 1960. Large cut-over blocks on north- and south-facing slopes and flat valley bottoms near Sitka were seeded in October 1960. Similar and adjacent cut-over blocks were left unseeded for comparison. The effect of seeding as measured in 1961 is shown in figure 2. For example, on a south-facing slope 16 percent of the milacre (0.001 acre) plots contained at least one or more vigorous seedlings due to natural seedfall before and after logging. Artificial seeding on a similar south-facing slope increased the stocking percentage from 16 to 39. Eventually, following additional crops of natural seed and the influence of factors causing mortality, we will know more about the ultimate role of artificial and natural seedfall in establishing the new forest on this area.

A helicopter was used to sow the spruce-hemlock seed mixture used for the artificial seeding. Approximately one-third pound of the mixture (2 parts spruce to 1 part hemlock by weight) was sown per acre. This seeding rate was the equivalent of approximately 22,200 live spruce seeds per acre and 15,700 live hemlock seeds per acre, or slightly less than one live tree seed for each square foot. Precautions were taken to discourage birds, red squirrels, mice, and shrews from eating the seed by treating all seed with endrin and coating with aluminum powder. Both substances were used primarily to make the seed unattractive to these animals.

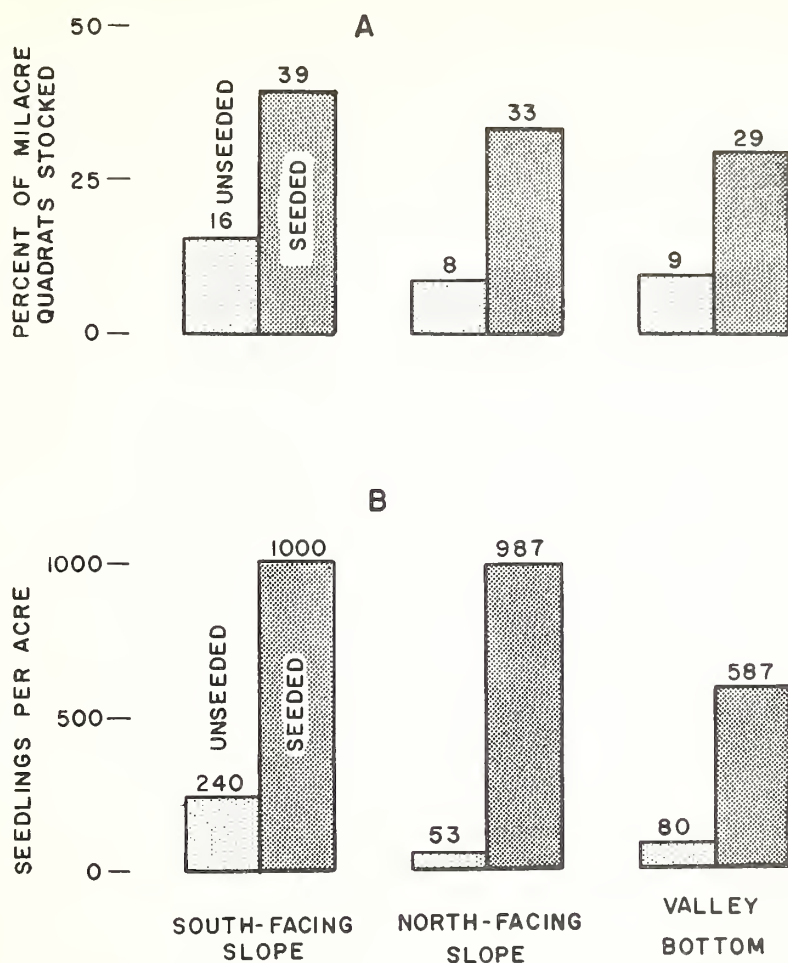


Figure 2. — *Western hemlock and Sitka spruce seedlings germinating in 1961 on seeded and unseeded cut-over land; near Sitka, Alaska.*
A, Percentages of 1/1000 acre (milacre) plots containing at least one seedling.
B, Number of seedlings per acre.

A new forest on a clear cutting can be started by seedlings growing from natural seed disseminated into the cut-over area plus seedlings that were established before the cutting and which survived the logging. Or, a new stand can be started from artificial seeding. An objective of the Sitka study is to help develop guides that can be used to determine when natural seedfall can be counted upon to establish the new forest, or when natural seedfall must be supplemented with artificial seeding such as seed sowing with a helicopter.

- Planted Douglas-Fir (*Pseudotsuga menziesii*), twelve years old from seed, and growing in southeast Alaska, now ranges from four to nearly ten feet in height and averages 5.8 feet. Height growth has been increasing annually (fig. 3). The trees appear to be established and vigorous (fig.4).

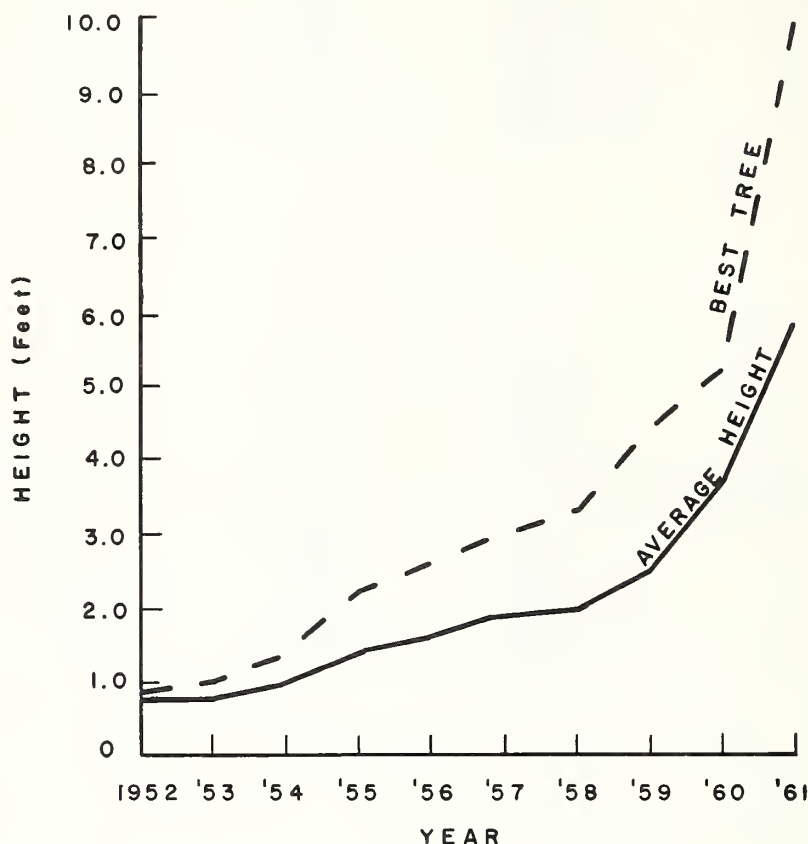


Figure 3. — Height growth of “average” and “best” Douglas-fir growing on Prince of Wales Island, Alaska.

Douglas-fir does not occur naturally in Alaska but it is found on the coastal islands of British Columbia as far north as latitude 50°30'N. Twenty-one two-year-old seedlings were planted near Hollis, Prince of Wales Island, in 1952 as a small scale trial to see how well the species would grow at this Alaska site. The latitude of the trial planting is 55°29'N., or about 350 miles north of the natural range. The nine survivors were transplanted to a more favorable south-facing slope in 1957. Eight trees are still alive. In spite of the rather unfavorable original planting site and the shock of the later transplanting, the trees now appear to be well established.

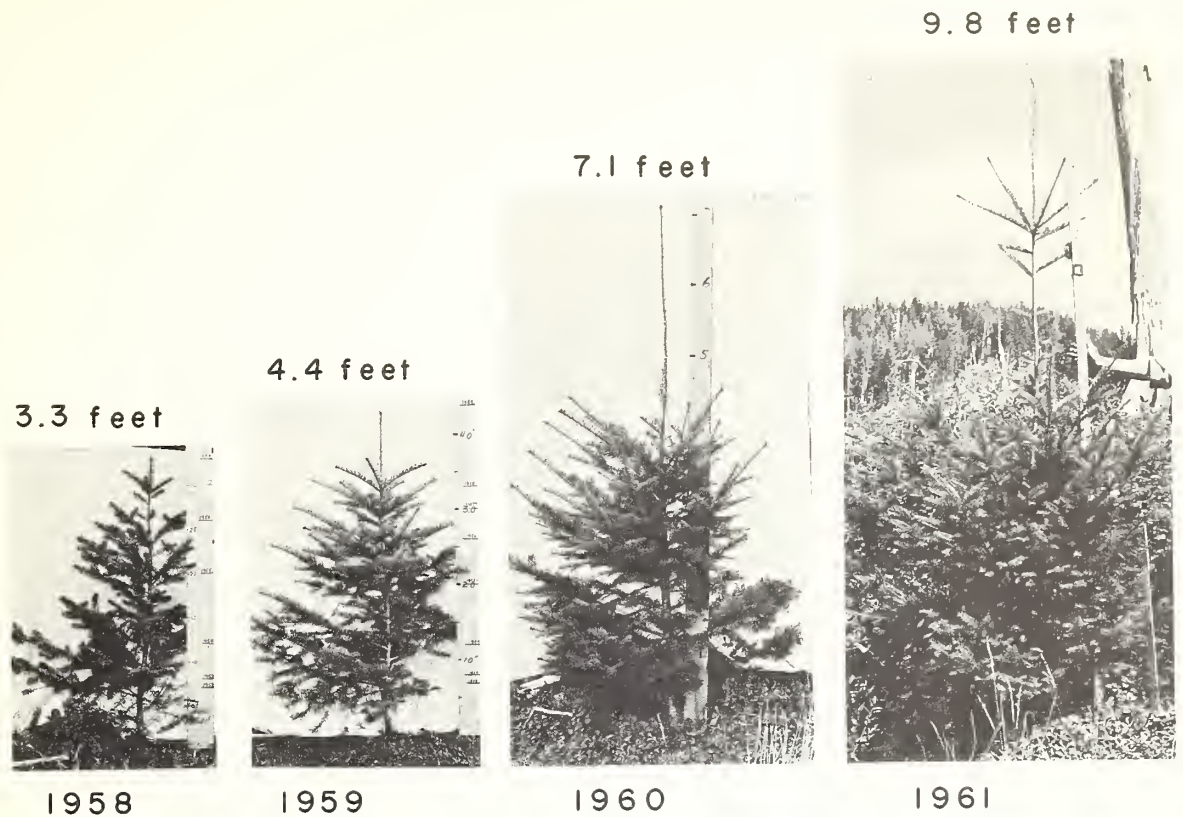


Figure 4. — Growth of a Douglas-fir planted on Prince of Wales Island, Alaska.

● Estimating How Long a Tree Has Been Dead. -- Needlefall is the first sign of disintegration of dead western hemlock and western redcedar. This is followed by the breakdown of small twigs and successively larger elements of the branch system. Eventually trunk breakage and bark sloughing begins.

Nine years' observations on trees killed by girdling, or poisoning with "ammate", have provided a basis for estimating how long a tree has been dead. By using the indicators summarized in table 1 we can estimate when a tree died. In turn, this information is useful in estimating mortality and growth in forest stands.

Table 1. — Guides for estimating how long western hemlock and western redcedar trees have been dead, Prince of Wales Island, Alaska.

Indicator ^{1/}	Western hemlock		Western redcedar	
	Dead 5 years or less	Dead 6 to 9 years	Dead 5 years or less	Dead 6 to 9 years
Needles	nearly gone to absent	absent	half gone to absent	mostly absent
Branchlets	partly to half gone	half gone to nearly gone	partly gone to absent	half gone to absent
Secondary branches	intact to partly gone	partly to nearly gone	intact to half gone	partly gone to nearly gone
Primary branches	mostly intact	partly to half gone	intact to partly gone	partly to half gone
Bark	mostly intact	mostly intact -- sometimes partly gone	intact	intact to partly gone
Bole	mostly intact	intact to partly gone	intact	intact to partly gone
Fungi		sporophore of <u>Fomes pinicola</u> and other fungi present		

^{1/} Key to indicator rating adjectives:

Term	Percent absent
intact	0
partly gone	1-24
half gone	25-75
nearly gone	76-99
absent	100

interior forests

● Seeding White Spruce in an 80-Year-Old Paper Birch Stand may require seed and seedling protection to be successful. Germination was poor in unprotected spring-sown seed spots and almost no seedlings were alive at the end of the third summer after sowing in a study of white spruce spot seeding in an 80-year-old birch stand. First season germination and third season survival, by periods of seedling protection, were:

<u>Seed spot protection</u>	<u>Germination, end of first summer (percent)</u>	<u>Survival, three seasons after sowing (percent)</u>
None	8	less than 0.5
Protecting screens removed at end of:		
First summer	49	3
Second summer	48	13
Third summer	61	42
" "	59	42
" "	60	41

Protecting the seed spots through the first summer with hardware cloth covers but leaving them unprotected after that provided little improvement in third-season survival. Protection through the first two seasons considerably improved third season survival. As might be expected, the highest third-season survival was obtained on seedspots protected during the entire period.

We want to know how large white spruce seedlings must be to withstand the smothering effects of birch and aspen leaves. Leaf litter is believed responsible for the death of small spruce seedlings. How much protection is required to successfully introduce white spruce by direct seeding in 80- to 90-year-old birch stands? This investigation will continue for several years.

● White Spruce Seed Production has been highly variable during a 3-year period. The seedfall of 123,000 seeds per acre in 1959 (table 2) was less than one percent of the seedfall measured in 1958. An early step in determining what seedfall means to the forest manager is a study now in progress to determine the quantity of seed produced; frequency of good, intermediate, and poor seed years; and criteria for rating seed years according to cone abundance. The study is in stands of 170-year-old white spruce.

Table 2. — Seedfall and seed viability of white spruce by cone crop ratings; interior Alaska.

Cone crop rating ^{1/}	Seedfall per acre	Seed viability	Year
	<u>thousand seeds</u>	<u>percent</u>	
4	123	22	1959
5	138	62	1957
9	16,512	65	1958

^{1/} Rated by a scale of 1 (cone crop failure) through 10 (many cones on all trees).

Seedfall is measured with traps of the type shown in figure 5 that are placed systematically within the study stands. The cone crop is rated according to a scale of 1 (cone crop failure) through 10 (many cones on all trees) just before seed dispersal begins in mid- to late August. Table 2 summarizes the first three years of study.

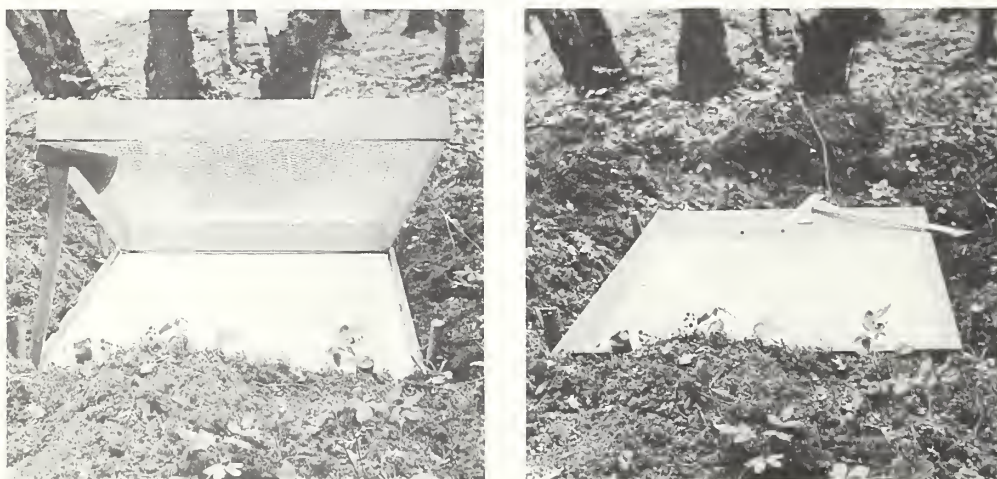


Figure 5. — One-fourth-acre seedtrap in a white spruce stand; Tanana River valley, Alaska.

● White Spruce Seed Loss due to insects appears to be an ever-present and, perhaps, variable factor influencing the production of seed. Cone and seed insects may consume much of the seed produced in poor cone crop years. Conversely, perhaps insect demands may be met by a small part of the seed produced in good cone crop years. The same relationship may hold for red squirrels, other small mammals, and birds.

Table 3, a summary of insect activity and seed production observed in the last four years, shows that few viable seeds have been produced by cone crops rating "four" (few cones on 50 percent of the trees or few cones on 25 percent of the trees and many cones on a few trees) or less. Evidently this is partly due to nonfertilization of pistillate cones and to insects. More information on the insects found is on page 15.

Table 3. — Average abundance of seed insects and seeds in white spruce cones; Tanana River valley, Alaska.

Cone crop rating <u>1/</u>	Seed insects per cone <u>number</u>	Seeds per cone		Year
		Viable <u>number</u>	Total <u>2/</u> <u>number</u>	
2.8	2	6	12	1960
3.8	4	6	65	1961
3.9	1	11	31	1959
9.0	<u>3/</u>	60	84	1958

1/ Based on a rating scale of 1 (cone crop failure) through 10 (many cones on all trees).

2/ Counts of bracts in the productive zone of 30 mature and well-developed 1960 and 1961 cones indicate that it is theoretically possible to have 105 seeds per cone.

3/ An occasional insect found.

These are early results from a study to determine how large a cone crop is needed to satisfy the seed demands of insects and how much seed remains for natural regeneration. The relationship between size of white spruce cone crops and seed loss due to insects is being investigated in the Tanana River Valley in cooperation with the forest insect research project. Systematic field sampling annually involves collecting 240 spruce cones from 60 stands from the Alaska-Canada border westward to Nenana.

Determining red squirrel-white spruce seed supply relationships is the objective of a study started last fall in cooperation with the University of Alaska. The University will investigate the biology and ecology of red squirrels in white spruce stands concurrently with our studies of white spruce seed production.

- Paper Birch Seed Production has ranged from 15 to 300 million per acre (table 4) in a study of the relationship of seed production to stand age and of the frequency of good, intermediate, and poor seed years. The record is much too brief to establish convincing trends, but the observation that a 47-year-old stand produced less than a fifth of the seedfall measured in older stands may indicate a trend.

Table 4. — Birch seed production and viability, by stand age; interior, Alaska.

Stand age	Seedfall per acre	Seed viability	Year
<u>years</u>	<u>thousand seeds</u>	<u>percent</u>	
47	15,184	11	1959
80	300,332	38	1958
<u>1/</u> 81	98,303	11	1959
102	81,837	2	1959

1/ Same stand as next line above but one year later.

Six to nine seed traps of the type shown in figure 6 have proved an adequate sample for each well-stocked even-aged paper birch stand being studied.



Figure 6. — Seed trap in a paper birch stand; Tanana River valley, Alaska. Trap consists of a galvanized flue thimble with a hardware cloth top and window screen bottom.

soil and water

● Sediment Washed Into a Salmon Stream soon begins to drop out. The relation between sediment drop-out and time is shown in figure 7 in which time is expressed indirectly as distance downstream from the point of sediment entry. The curve, based on a single day of sampling, is a rough integration of the influence pools, riffles, flow velocity, turbulence, and possibly other factors have upon drop-out. In measuring drop-out we attempted to sample the same "unit" of water at progressive downstream points.

Sediment in stream bed gravels can have a harmful effect on salmon eggs, larvae, and fry according to fisheries biologists. An understanding of the life history of sediment in salmon spawning streams is a prerequisite to developing methods to minimize the harmful effects of sediment. While we follow the movement of streamborne sediment the Fisheries Research Institute, University of Washington, is following the sediment-salmon relationships.

● Log Jam Formation and Shifting is believed to be affected by both height and duration of maximum streamflow. Trees felled into a stream (fig. 8A) were concentrated into several jams by a sudden but brief high streamflow following a 1.70-inch rainfall (fig. 8B). Streamflow responsible for building the jams reached 2,940 cubic feet per second--about 40 percent of the estimated record high flow for this stream. Later in the summer a 3.70-inch rain caused a peak flow of 2,790 cubic feet per second; this high flow lasted longer than did the previous one. The sustained high flow cleared the channel (fig. 8C) and consolidated several jams into a single large jam (fig. 8D).

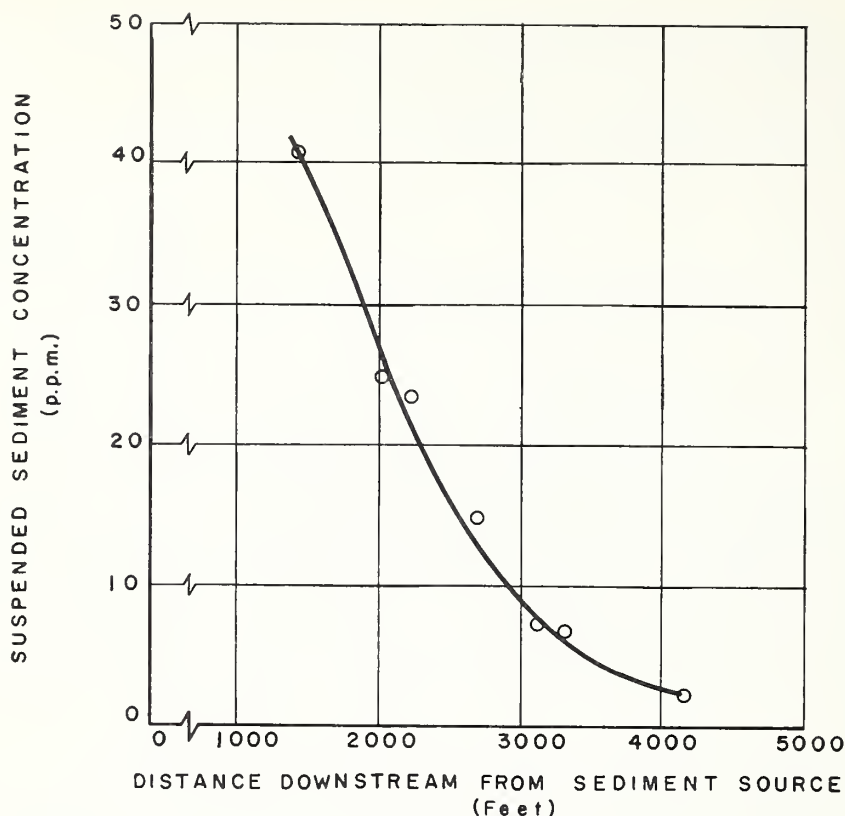


Figure 7. — Loss of suspended sediment from a "unit" of water as it progresses downstream from a sediment source.

High and long-lasting streamflows can change the channel shape at the log jam as well as above and below it. Cutting and filling of the stream bed was measured. However, we were not able to measure the effect shifting gravel had upon salmon egg survival nor the effect the jam, as a physical barrier, had upon salmon migration. A new approach was tried. In 1961 two log jams were built. Heights, thickness, length, and other details of the jam were recorded and the stream bed elevations were surveyed. The stream bed gravels were sampled for size and arrangement; the dissolved oxygen in the within-gravel water was sampled also. Both are factors in salmon egg survival. The effect of high streamflow on the log jams, stream channel, and stream bed gravels will be determined in the spring of 1962. Again, cooperation with the Fisheries Research Institute is being used.

Figure 8. — Development of a log jam.

A. Timber felled into a stream.



B. A sudden rise in streamflow, with a crest flow of 2,940 cubic feet per second, brought material from upstream to form the jam shown.

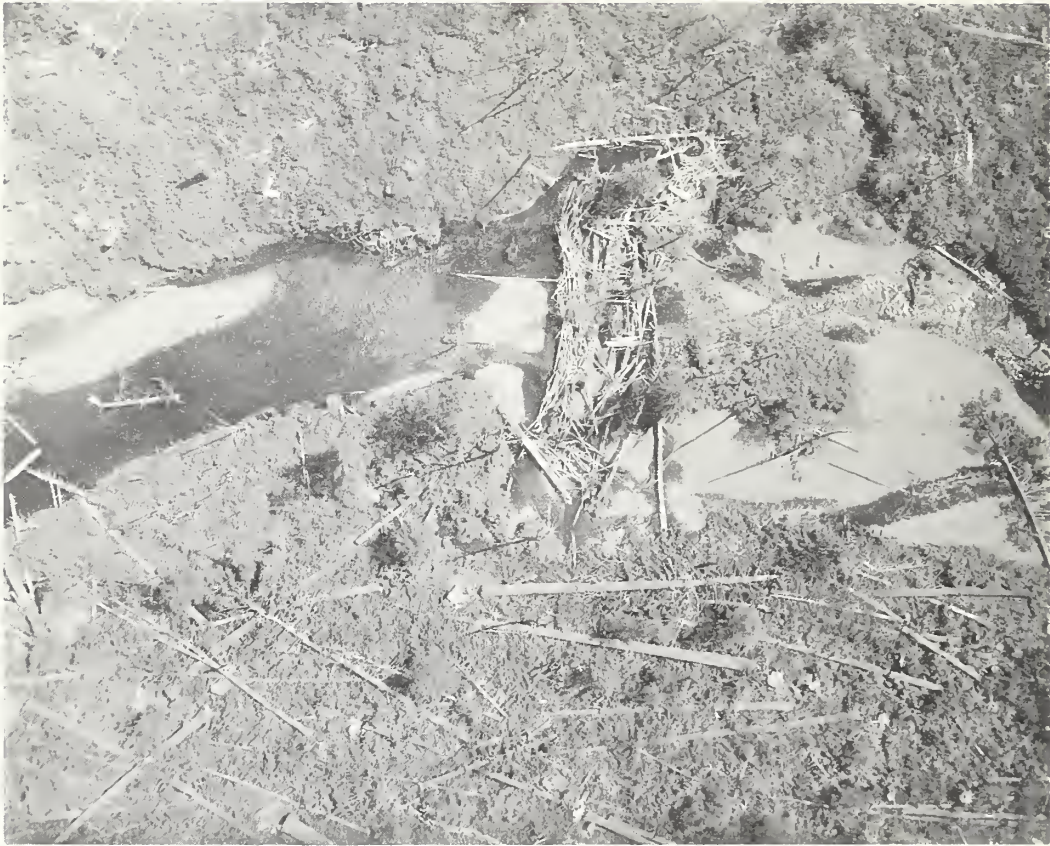


C. Then a crest flow of 2,790 cubic feet per second, but of longer duration than that in B swept the channel clear and concentrated this and other jams at a downstream point.



D. Jam shown in B, and several others, were concentrated into this jam. View is from across and downstream from A, B, and C.





Section of a salmon spawning stream photographed from a helicopter. Photographs such as this are taken periodically to study stream channel changes. This photo shows a natural log jam obstructing streamflow and causing changes in stream channel shape and pattern. Photographs of this kind are of known scale so that channel widths, log sizes, and other features can be measured from the photos themselves.

forest insects

- Leaf-Eating Insect Rearing in the Laboratory was successful and inexpensive using cages made from transparent plastic boxes. The boxes were modified to hold foliage and to allow moist air to circulate freely. The cut end of the leafy twig extended through the bottom of each rearing cage into a water-filled tray or petri dish (fig. 9) to keep the foliage fresh and the air moist. Foliage usually was replaced weekly, but it often stayed fresh 3 to 4 weeks. During the 1961 summer, over 3,000 insects were reared from eggs, immature forms, and larvae to the adult stage, primarily to aid in identifying the insects in their various growth stages.

Advantages in using this particular type of rearing cage are, (1) the foliage can be kept fresh and easily replaced when needed, (2) the insects can be observed without disturbing the cage, and (3) a large number of insects can be reared in a minimum of space because of the compactness of the cage.

- Insects Damaging White Spruce Seed most commonly have been the spruce seedworm (Laspeyresia youngana), the spruce seed maggot (Megastigmus sp), and the spruce cone-axis midge (Dasyneura rachiphaga).

White spruce cones have been collected in mid-August of the last four years from 60 stands in the Tanana River Valley. Rifles of .22 caliber are used to shoot two cones from each of two trees in each of the 60 stands. Cones are later dissected in the laboratory and, at this time, insects are identified and damage determined. See page 9 for more information on white spruce seed loss due to insects.

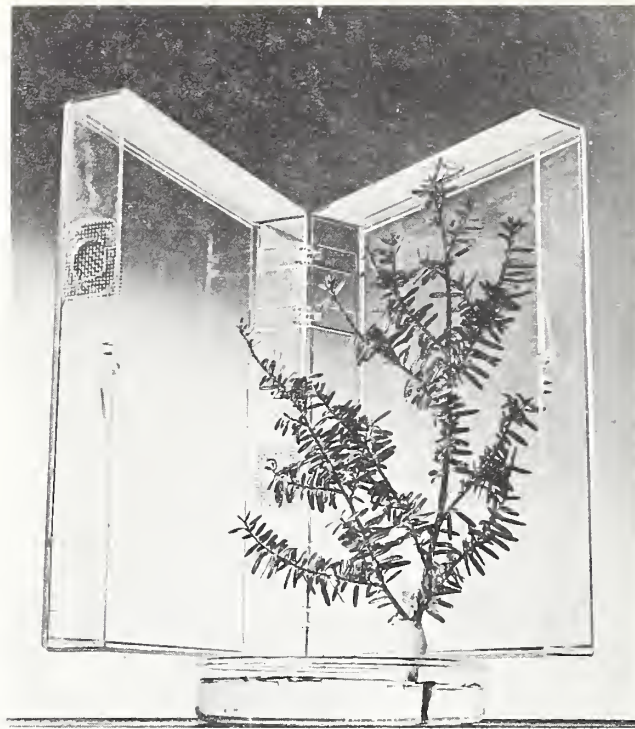


Figure 9. — Plastic rearing cage for maintaining fresh plant foliage for rearing leaf-eating insects in the laboratory.

● Pest Surveys were transferred to National Forest Administration on July 1, 1961. The transfer included responsibilities for forest insect detection, evaluation, and control activities. Henceforth, we will concentrate our efforts on the biological, ecological, and related investigations of the important forest insects. The systematic insect collection from the National Forests, and identification of these insects, will continue through a cooperative arrangement with the Alaska Region of the Forest Service.

The black-headed budworm (*Acleris variana*) 1959 outbreak in southern southeast Alaska increased to fairly high population levels through 1959 and early 1960. A decline in numbers was observed toward the end of the 1960 season, and this level was maintained throughout 1961 in most of southeast Alaska; the exception was northern southeastern Alaska where a small outbreak occurred at Sitkoh Bay.

Alaska spruce beetle (Dendroctonus borealis) continues to cause damage to white spruce in the Kenai National Moose Range and in localized areas on the Chugach National Forest. This infestation appears to have peaked in 1960, although 1961 losses still were high. Spruce beetle outbreaks were found in 1960 near Copper Center, on the east side of Copper River, and along the Little Tonsina River. Here the infestation continued through 1960 and probably will continue in 1962.

Hemlock sawfly (Neodiprion tsugae) populations followed much the same trends as did the black-headed budworm. Scattered high populations in 1959 continued into 1960 and declined in 1961. Outbreaks of the sawfly and the budworm have generally coincided. This suggests the two insects respond similarly to environmental factors.

Cedar bark beetle (Phloeosinus squamosus) outbreaks developed in Alaska cedar and western redcedar stands on Kuiu and Kupreanof Islands. In 1960 this outbreak extended over several thousand acres of scrub cedar stands growing on muskeg and other poorly-drained sites. Tree losses were severe in 1961 and are expected to continue in 1962.



These white spruce logs were cut within 25 miles of the Arctic Circle and brought to a sawmill at Circle, Alaska. They range from 18 to 24 inches in diameter at the large end. Logs such as these do not come from stunted, non-commercial stands that so many people believe typify interior Alaska. Our forest inventory will determine the area and timber volume of these commercial stands.

forest inventory

● Timber in the Prince William Sound Region is variable in most measurable aspects. Some stands of Sitka spruce and western hemlock will exceed 50,000 board feet per acre with trees 25 to 40 inches or more in diameter at breast height, and contain three to four 16-foot logs. Other stands contain scrub trees producing no merchantable volume. Such stands are usually growing in muskeg conditions (fig.10). The better stands are found on the better drained upland sites, as a fringe along the beaches, and along the mainland drainages. In general, trees are poor quality because limbs are large, abundant, and persistent (fig.11). These impressions were gained from photo interpretation and field work completed on the Whittier and Copper River blocks in June, 1960.

● Afognak Island Has a Relatively New Forest. Sitka spruce is the only commercial tree species on Afognak Island, and this one-species forest is less than 400 years old. First impressions are that these spruce stands are even-aged. However, recent measurements show that many of the stands are uneven-aged, and contain trees from about 70 to 250 years old.

Afognak forests were classified as 88 percent sawtimber stands with the remaining 12 percent classified as sapling and poletimber stands. The sawtimber plots averaged about 26,000 net board feet per acre. As elsewhere in the Prince William Sound region, timber quality is generally poor because of many large limbs that persist almost to ground level.



Figure 10. — Patchwork pattern of intermingled forest and muskeg on islands of the Prince William Sound area produce highly variable amounts of wood.



Figure 11. — Many large and persistent limbs on the trees lower the quality of the stands growing in the Prince William Sound area.

● Weather--a Deterrent to Forest Inventory. The Kenai working circle of the Chugach National Forest has escaped being fully photographed for inventory purposes. Since 1958, a contract for 1:15,840-scale photographs has been in force. Each season, poor weather for aerial photography has prevented completion of the contract. Rather than wait longer for the small amount of photography remaining to be done, the photo interpretation is being completed during the winter of 1961. A scale of 1:40,000 photography is being used to fill the gaps.

● Relationships Established for Some Tree Measurements. For cruising purposes, diameter inside bark at the top of the first 16-foot log in a standing tree can be determined from an outside bark measurement at the same height. Outside bark measurements at the top of the first log can be made accurately with optical instruments. The inside bark measurement at that point for the four principal timber species in southeast Alaska can be determined from the equation $Y = ax$, where:

Y = diameter inside bark at the top of the first 16-foot log

x = diameter outside bark at the top of the first 16-foot log

a = .9252 for western hemlock
.9475 for Sitka spruce
.9539 for Alaska cedar
.9396 for western redcedar.

Frequently, the volume of trees and stands already cut and removed is needed. If the fallen trees are still present, the volumes can be calculated easily. If only the stump remains, the diameter at breast height can be approximated by using the formula $Y = ax$, where:

Y = diameter at breast height

x = diameter inside bark at stump

a = .9434 for western hemlock
.9200 for Sitka spruce.

Knowing diameter at breast height, local volume tables can be used to approximate merchantable volumes in the tree now represented by a stump only.

● What is Full Stocking for Interior Stands? About 150 square feet of basal area per acre may be a good indicator of fully stocked hardwood and softwood stands in interior Alaska. Basal area was computed on 55 field plots with these results:

Class	No. plots	<u>Basal area/acre</u> (sq. ft.)
<u>All spruce:</u>	<u>38</u>	<u>154.8</u>
Poletimber	15	155.5
Sawtimber	23	154.4
<u>All Hardwood:</u>	<u>17</u>	<u>157.3</u>
Poletimber	14	150.8
Sawtimber	3	187.7
<u>All classes:</u>	<u>55</u>	<u>155.6</u>

The range in basal area for the 55 plots at the 5 percent confidence level was 145.6 to 165.6 square feet per acre.

We have used the basal area factor 75 prism with a one-tree expectancy to determine basal area per acre (11.0 and 9.0 inches d.b.h. were minimums for hardwoods and spruce sawtimber, respectively, while 5.0 inches was minimum for hardwood and spruce poletimber trees.) One tree, meeting the diameter requirements and within the circular "prism plot", represents 75 square feet of basal area per acre. Analysis of these records on 55 plots suggested that about half of the 55 plots were overstocked. This seemed unreasonable based on preliminary yield tables. Furthermore, if two trees per plot met the minimum diameter measurements, the projected basal area per acre would approach 150 square feet. This ties in closely to the results in the above tabulation. Our study of stocking and the most applicable prism factor will continue.

publications

Miscellaneous Publications

1. Lutz, H. J.

1960. History of the early occurrence of moose on the Kenai Peninsula and in other sections of Alaska. 25 pp. Moose are believed to have been present in the region long before the 1880's--an often referred to date of their arrival.

Technical Notes

45. Gregory, R. A.

1959. Identification of spruce seedlings in interior Alaska. 6 pp. Serrulate-edged cotyledons and leaves distinguish young white spruce seedlings from the smooth-edged cotyledons and leaves of young black spruce seedlings.

46. Downing, George L.

1960. Some seasonal growth data for paper birch, white spruce, and aspen near Fairbanks, Alaska--1958. 3 pp. Leader and radial growth measurements were made from May to July and August.

47. Gregory, Robert A.

1960. The development of soil organic layers in relation to time in southeast Alaska. 3 pp. Depth, oven-dry weight, and volume weight are reported for forest stands 125, 230, and 300 years old.

48. _____

1960. Estimating site index in sapling and pole stands in southeast Alaska. 3 pp. Length of the six-node span beginning at the first node above breast height is useful in estimating site index.

Technical Notes.--continued

49. _____
1960. Cubic-foot volume tables for paper birch in Alaska.
1 p. plus 4 tables. Volume tables based on measurements of
340 trees distributed widely in Alaska.
50. Harris, A. S.
1960. 1959 cone crop report for Alaska tree species. 3 pp.
Continuation of annual reporting system started in 1956.
51. Bones, James T.
1961. Estimating spruce and hemlock d.b.h. from stump
diameter. 2 pp. Average of two inside-bark-diameter stump
measurements made at right angles to one another and
multiplied by a constant gave a good estimate of d.b.h.

Forest Insect Survey Reports

6. Downing, G. L.
1960. A cedar bark beetle outbreak. 2 pp. Both western
redcedar and Alaska-cedar in scrub stands were dead and
dying on several thousand acres of Kuiu Island.

Articles in Periodicals and Books

- Helmers, A. E.
1960. Alaska forestry--a research frontier. Journal of
Forestry. 58(6):465-71. Forest research is believed to be the
key to the intensive utilization and management of Alaska's
forest resources.



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